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The following, received through the Mineralogical and Geological Section, was also ordered to be printed :—

NOTES ON THE GEOLOGY OF CHESTER VALLEY AND VICINITY.

BY THEO. D. RAND.

In a recent reply to criticisms by Dr. Frazer of statements in regard to the serpentine outcrops, etc., described in Vol. C 6 of the Second Geol. Survey of Pennsylvania, I stated that I would exhibit before the Academy specimens from the outcrops in question. Dr. Frazer stated (*Am. Nat.*, Sept., 1883, p. 525) : "At the same time it must not be forgotten that what one observer would regard as evidence of a serpentine outcrop, another would not. * * * It would seem to be only thus that such wide divergencies as are here noted are explicable."

I have here specimens from the serpentine outcrops which I had stated were overlooked in C 6, and specimens from two outcrops represented in C 6 to be serpentine, which I questioned. I think they speak for themselves, but if any member has any doubt or question, I trust the matter may be so discussed as to elicit the truth.

I desire also to call attention to certain statements in the survey of Chester Co., C 4, recently published, statements with which my observations do not agree.

1. The non-existence of Potsdam sandstone, or a sandstone very closely resembling Potsdam, south of Chester Valley.

C 4 says, pp. 34, 124 : " The quartzite failed altogether on the southern side of the valley." " No Potsdam sandstone has been detected anywhere along the southern edge of the limestone area."

I have here specimens from Samuel Tyson's, on north flank of South Valley Hill, near King of Prussia station, Chester Valley, and from three localities in Cream Valley (between the South Valley Hill and the Radnor syenitic gneiss range), one, on the Brooks farm, about 100 yards west of the line dividing Delaware county from Montgomery and 300 yards northeast of the southwest corner of Upper Merion township; another, one-half mile west of this, near and south of the limestone on Stacker's place, and the third the Pennsylvania Railroad cut northwest of Wayne station, just north of the trap, in which cut Dr. Frazer, p. 283, speaks of finding sandy gneiss[1] with a hard serpentine-like mineral. I have also the eurite of Barren Hill for comparison.

It will be seen that the correspondence is exact—the micaceous partings, the rhomboidal cleavage, the minute tourmalines—all agree.

I have also a specimen of the trap of the Conshohocken dyke which crosses this cut about 100 feet southeast of the eurite. I could find no serpentine-like rock there, nor any other hard rock; the rocks are much decomposed, but the gneiss of Rogers' altered primal is there unmistakably.

2. I have also specimens (loose in the soil) from immediately south of the eastern end of the serpentine, stated, on p. 87, to be bounded both south and north by talcose slate. The rock is Rogers' altered primal.

3. On page 87 it is stated: "It is evident that even a synclinal belt of serpentine 2000 feet wide, or even 400 feet wide, can mean nothing else than a great thickness of the talc mica schist formation, metamorphosed more or less completely into serpentine, and a good cause for such alteration is present in an extensive outburst of trap close beyond."

"Everybody familiar with the surface of Delaware and Chester counties knows how *almost invariably* its trap and serpentine appear together."

If this is true, how can it be explained that a few miles further east, what seems to be admitted (p. 282) to be the same serpentine belt is wholly within the gneisses of C 6 (Rogers' altered primal), over 1000 feet south of the trap, with gneiss, hornblende schist, steatite and limestone intervening, and that the trap passes eastward for some five or six miles, at least, from Wayne station, P. R. R., to a point far east of Conshohocken, through the hydromica schists of the South Valley Hill to Bethel Hill without a trace of serpentine.

At what locality in Delaware county, among its numerous serpentine outcrops, does trap, properly so-called, occur?

It does not appear at Lenni, Media, Blue Hill, Marple, Newtown, nor at any of the numerous outcrops of the Lafayette belt, nor of that of the steatite belt on the south, nor of the Radnor belt in Radnor. In Easttown they do appear together, but can this possibly be construed to be more than that converging lines must meet?

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[1] This quotation is erroneous; in place of "sandy gneiss" it should be "a decomposed friable white gneissoid rock."

4. P. 84: "The southern edge of the South Valley Hill belt of talc mica slates is defined upon the map by a chain of dots and stripes of two colors, representing outcrops of serpentine, and outcrops of crystalline limestone. Were these outcrops ranged in more than one line, the task of explaining their appearance would be far easier. * * * It looks as if the serpentine might be a subsequent modification of the limestone. No case is recorded of the serpentine and crystalline limestone of our line being seen in contact." I do not dispute the last sentence, but the specimens show a variety of rocks in Radnor *between* the serpentine and limestone, which there occupy, as shown on my map, approximatively parallel positions a thousand feet and more apart—conclusive evidence that in that part of the line at least they have no possible connection.

The map in C 4 shows, as clearly as possible on so small a scale, that the line of limestone outcrops is north of the line of serpentine outcrops; all the limestone outcrops shown are west of the west end of the serpentine outcrops.

There is some evidence that this serpentine belt is an altered enstatite.

I show a specimen from near Devon Inn, Easttown township, which seems almost certainly altered enstatite; and specimens of undoubted enstatite from the Lafayette belt, the serpentine of which so strongly resembles that of the Radnor belt, both in structure and accompanying minerals.

5. The statement, p. 282: "The east end of this (the Easttown and Williamstown serpentine belt) continues much further into Montgomery county."

This is certainly an error, caused, perhaps, by confusing this belt with that north of it, as was done in C 6. This belt ceases abruptly on the land of Hon. D. J. Morell, in Radnor township, Delaware county, where the contour suggests the possibility of a fault. The lithological difference of the belts may be seen by the specimens produced. The northerly belt begins on the land of Brooke, about one-fourth mile northwest of the easterly end of the Radnor outcrop, east of Radnor station.

5. On p. 138, a Mr. Morely is quoted, without comment, as stating that the Conshohocken trap follows the *summit* of Bethel

Hill into Delaware county, terminating near the road leading from the Lancaster turnpike to the King of Prussia.

In fact, it is nowhere near the summit, but on the south flank, or at the foot, and so far from ending at the road mentioned, it extends several miles to the westward, its outcrops almost continuous.

7. P. 140: "Near Mr. Hitner's house, Marble Hall, there occurs a thin bed of very ponderous rock, resembling closely a white crystalline limestone. It contains, however, but a moderate proportion of carbonate of lime, and consists chiefly of the carbonate of strontia." Whence there is deduced a bond of connection between the valley limestone and the No. 11 limestone of the valleys of middle Pennsylvania.

Was carbonate of strontia ever found there? Is it not the well-known sulphate of baryta from that locality mistaken for carbonate of strontia?

8. P. 282: "An old quarry close by the Spread Eagle hotel, which is now filled with fragments of trap and rubbish, shows serpentine along with the schistose matter, with a dip about S. 35 E., and seemingly about 35°, etc."

"This quarry is over the line, in Delaware county."

This is an interesting contact. I regret that I have been unable to find it; the only quarry in that vicinity that I can find is about 200 feet west of the Spread Eagle, on the north side of the Lancaster turnpike, nearly opposite Pugh's store; but it contains no serpentine, and is in Rogers' altered primal quarried thence for the turnpike. It was much filled up with trap and rubbish, but has been recently opened again. Old residents assure me that it is the only quarry in Delaware county in that vicinity.

9. P. 282: "As soon as one passes the creek north of Radnor station * * * the measures assume an unctuous, schistose, partly chloritic character."

P. 284: "Fragments of chloritic mica schist."

P. 287: "Willistown, broad conchoidal mica schist, containing much *chlorite* and milk quartz."

Yet Prof. Frazer contends rightly (*Am. Nat.*, October, 1883, p. 1021) that this region contains *hydro-mica* schists only; that the expression "talc mica" is erroneous, as the rocks contain no talc; do they contain chlorite?

Dr. Frazer says (*Am. Nat.*, May, 1883, p. 524): "The observation of the intersection of the serpentine belt by the trap, which has a more northerly trend in Easttown, is *interesting*, but *not new.*" My words were: "A mile southeast of Berwyn, the latter can be seen almost, if not quite, in contact with the serpentine, the trap, however, being on the south of the serpentine. The same is true south of Paoli, except that the trap appears to be on the north side." Prof. Rogers (p. 168) speaks of this trap as "occurring along and outside the northern edge of the serpentine, in a succession of narrow, elongated dykes, ranging more northeast and southwest than the serpentine. These I have not examined, but such structure agrees precisely with what I have observed of the serpentine further east."

This interesting occurrence is not upon the map in C 4; no trap whatever is shown north of the large serpentine outcrop south of Paoli.[1]

Dr. Frazer (*J. Frank. Inst.*, October 1883) kindly compares my criticism with those of the good old gentlemen who, during the war, criticized the army officers, from a safe distance at their comfortable breakfast tables. This is not fair; every observation I have made has been made on the spot and on foot, and in proof of this Dr. Frazer has not pointed out a single error of fact. Had all the observations in C 6 and C 4 been similarly made, many blunders like those of serpentine in the Bryn Mawr cut, in the cut northwest of Wayne, and on the Gulf road north of Matsons' Ford road, would not have appeared.

"But it is not a fact that Rogers' altered primal is a well-defined rock; on the contrary, a more heterogeneous collection of gneiss, mica schists, hydro-mica schists, chlorites, feldspar porphyries, clays and quartz slates than are found in the regions which he colored as altered primal it would be difficult to collect from the two hemispheres."—Dr. Frazer, J. F. I., October, 1883.

I referred to the rock *described* by Rogers. Is it not possible that Dr. Frazer has included, in the above, adjacent rocks which Rogers had no intention of including, as the scale of the map precludes the possibility of accurate mapping; and the rocks mentioned by Dr. Frazer do lie adjacent; but the peculiar rock here shown and so well described by Rogers, is, at least through Lower Merion, Radnor and Easttown, very well defined indeed. Its breadth nowhere exceeds 800 feet, I think, and this on Rogers' map would be $\frac{1}{33}$ of an inch; its outcrops are almost continuous, and between, its existence in the fields is constant.

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[1] In my review, J. F. I., September, 1883, I inadvertently located this in Easttown. It is really in Willistown.

Dr. Frazer attempts a joke founded upon his impression of the absence of an allusion to the serpentine in Radnor and Easttown, in my criticism of C 4. It would have been well for him to have read the paper again. He will find on page 33 an "allusion" to the serpentine in Radnor; on page 34 a map of the outcrops in Radnor and some of those in Easttown.

I did not describe the echelon structure of the serpentine outcrops as a theory, as Dr. Frazer says, but, as a fact, the underground structure I do not attempt to demonstrate. That our observations agree within limits that do not affect the question, is shown in the table given below.

The lines of strike are in part deduced from the dips given by Dr. Frazer, but it may be well to quote from C 4, p. 218: "The serpentine * * * where exposed, it is so fractured and broken as to make the determination of its dip very difficult or altogether impossible. But its strike cannot unfrequently be pursued in almost straight lines for miles."

For this reason, in recording my observations, I preferred to give the dip and strike separately—for the dip varies greatly, the strike does not.

Outcrops.	Strike on map, C 4.	Strike, Frazer, J. F.I. Oct., '83.	90° from Dip. Frazer.	Strike, Rand.	Difference.
1. ½ mile E. of Radnor station.		Nearly E. and W.	N. 70 to 85 E.	Nearly E. and W.	0 to 20°
3. ⅓ mile N. W. of Radnor station.			N. 70 E. N. 60 W. (? N. 60 E. ?)	N. 60 E.	10° 120° or 0°
6. S. W. of Old Eagle station.	N. 70 E.	± N. 30 E.		N. 40 E.	10°
7. N. W. of and near Devon Inn.				N. 50 to 60 E.	
9. Ivister, S. of Berwyn.	N. 76 E.	N. 40 E.	N. 40 E.	N. 40 E.	0°

A line joining the outcrops 6 and 9 on map C 4 is N. 83 E.
One joining the Radnor outcrops on map by Hopkins, N. 80 E.

Outcrop 3 runs for nearly 1500 feet parallel, or nearly so, to a lane. The bearing of this lane, by surveys recited in the deeds, is N. 62° 40′ E.

Now if the lines of strike given by Dr. Frazer be plotted on the map, it will readily be seen that while a line about N. 83 E. will cross all of them, the strike of all will cross this line at angles from 23° to 43°, except the first. The strike of the outcrops, as given on the map, is wrong, as shown by Dr. Frazer's own figures; but in spite of this the echelon structure is delineated in the two outcrops south and southwest of Old Eagle station, the error—making them two parallel outcrops—being due to the fact that the westerly one is not over 400 feet long, the easterly not over 200, while on the map each is made over 1000 feet long.

Mr. Hall remarks (*Am. Nat.*, June, 1883, p. 647) that I do not account for the absence of slates on the north side of the valley. From the specimens exhibited it will be seen that there are in the North Valley Hill slaty rocks with segregated quartz closely resembling those of the South Valley Hill, though it is true that as a whole the hills are not alike.

I have here specimens to illustrate the succession of rocks north and south of the Radnor gneiss belt.

I would particularly call attention to the rocks immediately south of the Radnor gneiss belt. Their resemblance to those on the north is striking, and it seems worthy of further investigation whether the belt of fine grained gneiss breaking into rhomboidal fragments and connected with a white feldspathic rock, may not be identical with the eurite and adjacent rocks on the north.

I have also two more specimens of the quartzite with supposed fucoidal markings, one of which, from the Old Gulf road east of Bryn Mawr, contains them unusually well defined.